ON THE CHARACTERISTICS OF PUPAL CASE, ADULT AND EGG OF INDIAN SPECIES OF *LIPALEYRODES* TAKAHASHI (ALEYRODIDAE: HOMOPTERA) WITH DESCRIPTION OF A NEW SPECIES[1]

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(With four text-figures)

Key words: *Lipaleyrodes vernoniae,* Aleyrodidae

Four species of *Lipaleyrodes* Takahashi from India were studied for the characteristics of the pupal case, egg and adults to understand their significance in aleyrodid taxonomy. Among the four species one species from *Vernonia cinerea* (Compositae) has been described as a new species, namely *Lipaleyrodes vernoniae.* No difference was observed in the structure of egg in the species studied. However, in the adults the compound eyes are joined by a single ommatidium as in *Bemisia tabaci,* that suggesting probably Bemisini and Lipaleyrodini share this characteristic feature at the tribal level. The study indicates that at species level variations in the number of setae in meso- and metatibial brush and in the metatibial comb, and the pattern of distribution of setae on the paramere may play significant role in species determination.

Introduction

In 1962 Takahashi erected the genus *Lipaleyrodes* characterised mainly by submarginal area being distinctly defined by a dorsal disc with wax plates in large clusters arranged in a row. Mound and Halsey (1978) reported a new combination *Lipaleyrodes breyniae* for *Trialeurodes breyniae* which was described in 1931 by Singh on *Breynia vitis-idaea* (Burm. f.) Fischer [=*Breynia rhamnoides* (Retz.)] from India. However, David and Subramaniam (1976) added two new species, namely *L. crossandrae* and *L. euphorbiae* from India and presented a key for Indian species of *Lipaleyrodes.* Jeritta and David (1986) reported the occurrence of *L. euphorbiae* on *Phyllanthus amarus* Schum. and Thonn. *(=Phyllanthus niruri)* and *P. maderaspatensis* L. from India and briefly indicated the life history of the species. In 1990 specimens of *Lipaleyrodes* infesting *Phyllanthus* sp. and *Euphorbia* sp. were received from the ICAR Research Complex at Port Blair in Andaman and Nicobar Islands.

Presently aleyrodid taxonomy is based entirely on the so-called "Pupal case" and little is known about the morphology and characteristic features of the egg and adults, particularly the male genitalia of Indian aleyrodids excepting for the contribution of Singh (1931) in respect of a few species. No serious attempt has been made so far to relate the characteristic features of the egg and adult with that of the pupal case in aleyrodid taxonomy and the need for such an approach has been stressed recently by Gill (1990). Esther (1991) made a preliminary study of the pupal case, egg and adult morphology of a few species in relation to aleyrodid taxonomy. The present paper deals with a detailed comparative study of the egg and adult characteristics with that of the characteristic features of pupal case of the Indian species of the genus *Lipaleyrodes* Takahashi.

Materials and Methods

Material: This study was based on the various species of *Lipaleyrodes* collected by us and also examination of the type species of *Lipaleyrodes breyniae* (Singh).

Methods: *Egg*: Eggs were removed from the leaf surface by means of a fine needle and transferred to lactic acid and examined under a stereoscopic binocular microscope. Such eggs were stored in lactic acid for three to four days till they became transparent. The eggs were then transferred to polyvinyl lactophenol on a slide. A cover glass was

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placed carefully to avoid air bubbles and slides were allowed to dry before observations.

Pupal case: In the preparation of permanent mounts of the pupal cases, the method suggested by Jesudasan and David (1991) was adopted.

Adult: To study the adult characteristics the method suggested by Mound (1965) was followed. Adults taken dry from stored leaves or collected live were placed in solution containing ethyl alcohol 5 parts, lactic acid 1 part and distilled water 4 parts. The specimens were then transferred to a stronger solution (ethyl alcohol 35 parts, lactic acid 35 parts and distilled water 30 parts) for 4 to 5 days. In the case of fresh specimens it may be kept for a day. Finally they were transferred to the preservative containing chloral hydrate 40 g, glycerine 20 CC and distilled water 40 CC. The adults were mounted in Berlese after first detaching the head, abdomen and wings so that all parts will be always present in the same slide. After mounting, the specimens were ringed with Euparal first, then with Murrayite or thin Canada Balsam. All observations, micro-measurements and camera lucida drawings of egg, pupal case and adults were made using Carl Zeiss LOBOVAL 4 microscope.

Results

Specimens of *Lipaleyrodes* collected from various host plants were examined critically and the description of the various stages of the species studied has been provided. Key for the Indian species of *Lipaleyrodes* based on characteristics of male genitalia and metatibia of adult and pupal case has also been provided.

Key to Indian species of *Lipaleyrodes* Takahashi (based on adult and pupal case)

1. Setae on first abdominal segment wanting; each submarginal cluster with 4 or 5 wax plates; paramere with 4, 7 and 7 setae respectively on inner, mid and outer regions ..... *breyniae* (Singh)
   Setae on first abdominal segment present 2
2. Wax plates in clusters polygonal or oval shaped; metatibial brush with 2 setae and comb with 12 or 14 setae 3
   Wax plates in clusters petal-like and irregular shaped; metatibial brush with 3 setae and comb with 11 setae ..... *vernoniae* sp. nov.
3. Wax plates in clusters oval; metatibial comb with 12 setae; paramere with 4, 8 and 7 setae respectively on inner, mid and outer regions ..... *crossandrae* David & Subramaniam
   Wax plates in clusters polygonal; metatibial comb with 14 setae; paramere with 4,7 and 5 setae respectively on inner, mid and outer regions....*euphorbiae* David & Subramniam

Genus *Lipaleyrodes* Takahashi 1961

Lipaleyrodes Takahashi, 1962, *Proc. Ent. Soc., London (B)* 31:100.

Type species: *Lipaleyrodes phyllanthi* Takahashi 1962: by monotypy.

Pupal case ovate, margin crenulate, tracheal pores, clefts or combs wanting, not strongly sclerotized; submarginal area distinctly defined from dorsal disc, broad with wax plates in large clusters arranged in a row; dorsal setae discernible; abdominal segment VII shortened medially; vasiform orifice large, subcordate; operculum occupying over half the length of orifice; lingula knobbed, exposed with dorsal expanded part longer than wide.

1. **Lipaleyrodes breyniae** Singh (Fig. 1, A-D)

Trialeurodes breyniae Singh, 1931, *Mem. Dep. Agric., India,* 12 (11): 49.

Lipaleyrodes breyniae (Singh), Mound and Halsey 1978, *Whitefly of the World,* p. 167.

Pupal case: Pupal case pale yellowish; found in groups on the undersurface of leaf with dense bluish white fluff composed of fleecy curled fine filaments of waxy secretion; 0.85 mm long and 0.65 mm wide.

Margin: Finely crenulate; paired anterior and posterior marginal setae evident, 10 µm long; thoracic and caudal combs and pores absent.

Dorsal surface: Dorsum with two pairs of dorsal setae; cephalic setae 50 µm long, VIII abdominal setae laterad of vasiform orifice, 62.5 µm long; I abdominal setae wanting; caudal setae submarginal, 85 µm long. Abdominal segment VI, 37.5 µm long; segment VIII longest, 55 µm long; segment VII medially shortened, 5 µm long. Dorsal disc separated from submargin by a distinct line. Submargin broad with 11 pairs of clusters of wax plates, each cluster consisting of 4 to 5 oval shaped

wax plates (Fig 1, B).

Vasiform orifice little longer than wide, 87.5 µm long and 77.5 µm wide; operculum 55 µm long and 37.5 µm wide. Lingula large, exposed, setose, bearing a pair of setae sub-apically.

Ventral surface: A pair of ventral abdominal setae present, 12.5 µm long and 37.5 µm apart. Antenna does not extend beyond base of prothoracic leg. Setae at base of legs and rostrum wanting.

Materials examined: 3 specimens on *Breynia rhamnoides*: INDIA: Bihar, Pusa, 11.4.1929, K. Singh (In the collections of Division of Entomology, IARI, New Delhi); 8 specimens on *Indigofera cassiodes,* Rottler ex DC. Bangalore, 6.5.93, K. Thenmozhi.

Hosts: *Breynia vitis-idaea (=Breynia rhamnoides)* (Euphorbiaceae), *Indigofera cassiodes* (Papilionaceae).

Distribution: INDIA: Pusa (Bihar), Bangalore (Karnataka). Reported for the first time from South India.

The description of the egg and adults provided here are based on that of Singh (1931).

Egg: (Fig. 1, C): Measures 0.19 mm long and 0.095 mm wide; sub-oval in outline with smooth surface; laid on under surface of leaf generally arranged in the form of circle.

ADULT MALE: Length from vertex to tip of claspers 1.03 mm; pale yellowish with a light orange tinge; eyes crimson, divided. *Antenna*: Seven segmented; II segment sub-pyriform, hairy, 0.046 mm; III sub-cylindric, imbricate 0.085 mm, armed with two primary sensoria and the sensorial cone near the distal end; IV sub-cylindric, 0.019 mm; V sub-cylindric, 0.023 mm long with a primary sensorium apically; VI sub-cylindric, 0.023 mm with a small sensorial cone apically; VII sub-fusiform, hairy with a primary sensorium and a sensorial cone in the distal half and a setae on the tip of the segment. *Wings:* Forewing hyaline, immaculate, not mottled, 0.85 mm long and 0.28 mm wide; radius as a smooth flexure and cubitus as a streak. Hind wing 0.76 mm long and 0.25 mm wide; radius as a smooth flexure. *Legs:* Hind tibia 0.304 mm long with ordinary rows of spines; proximal tarsus 0.095 mm; distal tarsus 0.076 mm. *Genitalia:* (Fig. 1, D): Parameres 0.031 mm at base, 0.086 mm long;

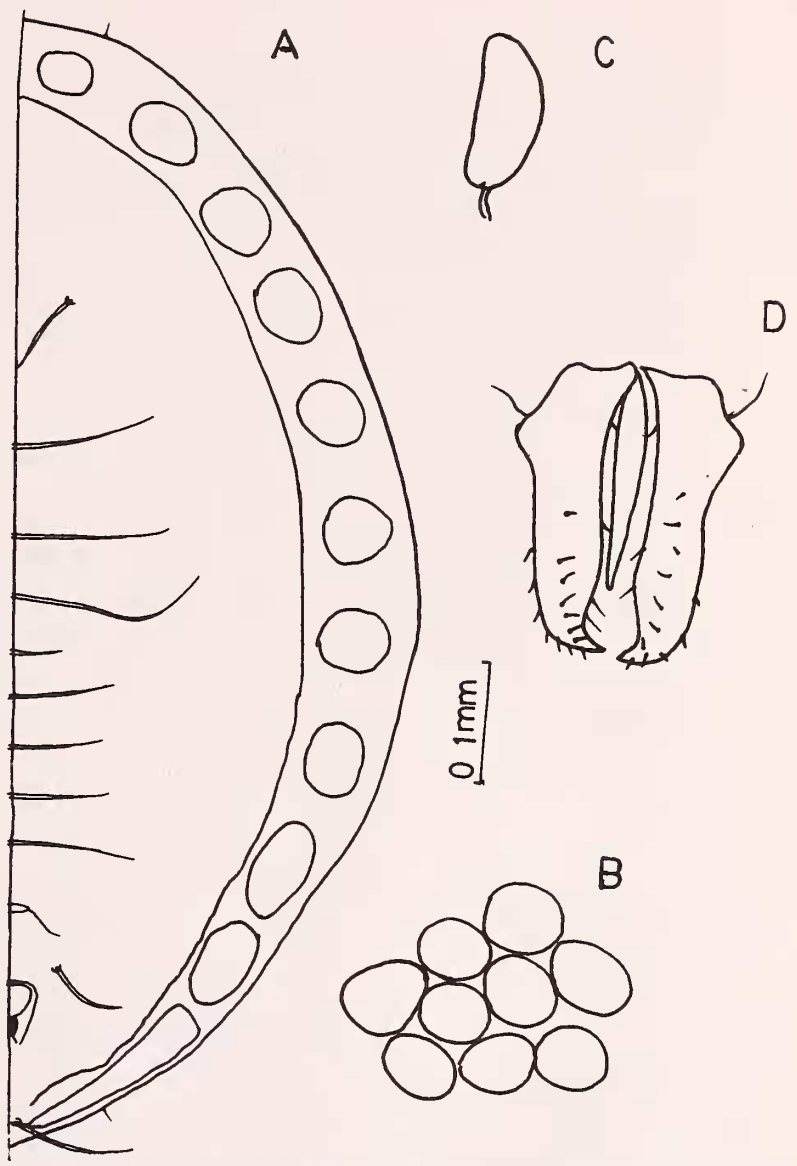

Fig. 1. *Lipaleyrodes breyniae* Singh: A. Pupal case; B. Cluster of wax plates; C. Egg; D. Male genitalia.

slightly narrowing distally and the sharp pointed tip incurved called apical spine. Aedeagus cylindric at base, tapering distally, shorter than clasper.

FEMALE: Body length meaures from vertex to tip of ovipositor 1.1 mm. *Antenna:* Seven segmented as in male, length being (in mm) II, 0.046; III, 0.101; IV, 0.023; V, 0.031; VI, 0.028; VII, 0.039. *Wings:* Forewing 0.95 mm long and 0.38 mm wide. Hind wing 0.85 mm long and 0.31 mm wide. *Legs:* Hind tibia 0.342 mm; proximal tarsus 0.095 mm; distal tarsus 0.076 mm.

2. **Lipaleyrodes crossandrae** David and Subramaniam
(Fig. 2, A-J)

Lipaleyrodes crossandrae David and Subramaniam, 1976, *Rec. Zool. Surv., India.* 70:201.

Pupal case: Found in groups on under surface

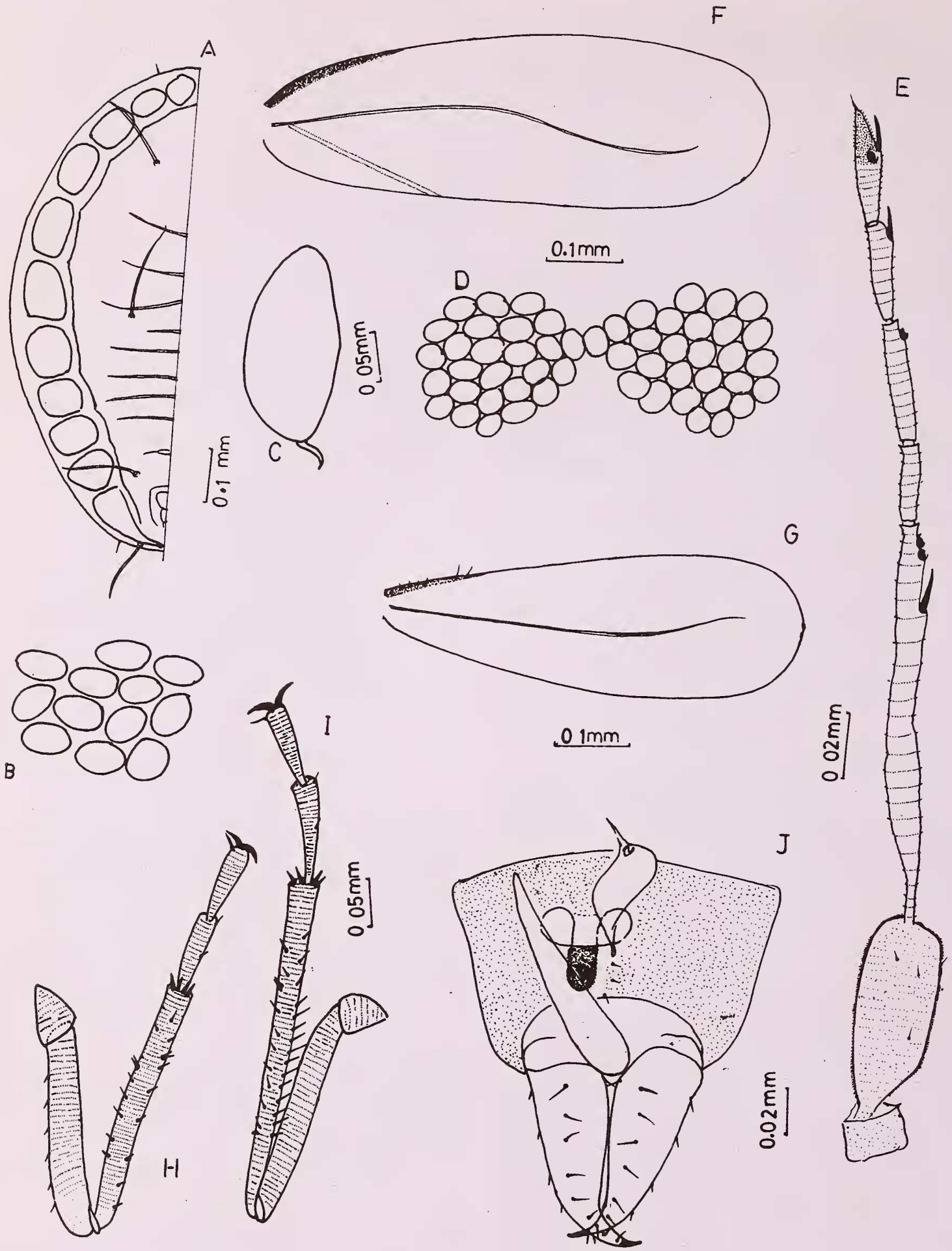

Fig. 2. *Lipaleyrodes crossandrae* David & Subramaniam: A. Pupal case; B. Cluster of wax plates; C. Egg; D. Compound eyes joined by single ommatidium; E. Antenna of male; F. Forewing of male; G. Hindwing of male; H. Mesothoracic leg of male, I. Metathoracic leg of male, J. Male genitalia.

of leaves in dense white fluff of fleecy curled filaments of wax. Pupal case white in colour, oval shaped, length 0.58-0.78 mm and width 0.41-0.50 mm.

Dorsal surface: Dorsum with three pairs of setae, long and quite characteristic; cephalic setae 100 µm - 127 µm long; I abdominal setae 146 µm - 160 µm long and VIII abdominal setae laterad to base of vasiform orifice, 88 µm - 125 µm long. Caudal setae submarginal, 80 µm - 110 µm long. Abdominal segment VI 37.5 µm long; segment VII, 5 µm long, medially shortened; segment VIII longest, 45 µm long. Dorsal disc separated from submargin by a distinct line. Submargin broad with 11 pairs of clusters of wax plates; each cluster consisting of 8-17 oval shaped wax plates (Fig. 2, B).

Vasiform orifice bluntly pointed at caudal end; 47 µm long and 52 µm wide with lateral ridges. Operculum wider than long, 28 µm long and 39 µm wide. Lingula large, more or less club shaped, setose, exposed, bearing a pair of long setae sub-apically, included.

Ventral surface: A pair of ventral abdominal setae, 36 µm long and 28 µm apart. Setae at the base of legs and rostrum wanting.

Materials examined: Holotype and 13 paratypes on *Crossandra undulaefolia.* INDIA: Tamil Nadu, Coimbatore, 15.11.1966. B.V. David; 7 pupal cases on *Achyranthes aspera* L., Tamil Nadu, Padappai, 28.7.92, K. Thenmozhi; 8 Pupal cases on unidentified Acanthaceae, Padappai, 7.6.1993, K. Thenmozhi; 10 pupal cases on *Blepharis maderaspatensis,* Coimbatore, 5.8.93, K. Thenmozhi.

Hosts: *Crossandra undulaefolia, Blepharis maderaspatensis* (Acanthaceae); *Achyranthes aspera* (Amaranthaceae).

Distribution: INDIA: Coimbatore, Padappai (Tamil Nadu).

Egg: In the case of *Achyranthes aspera* the egg is found on under surface of leaf mainly on either side of midrib deposited with powdery wax. Egg measures 0.2 mm long and 0.11 mm wide, pedicel measures 0.03 mm attached to leaf surface (Fig. 2, C). In *Blepharis maderaspatensis* female lays eggs on under surface of leaf deposited along with wax. Egg measures 0.2 mm long and 0.11 mm wide. In unidentified host plant eggs are laid on both surfaces of leaf deposited along with powdery wax. The egg measures 0.2 mm long and 0.12 mm wide and pedicel 0.03 mm.

ADULT MALE: Body light yellow in colour, legs and antennae pale, wings hyaline, eyes maroon, constricted in the middle and joined by a single ommatidium (Fig. 2, D). Body length from vertex to tip of abdomen 1.11 mm. *Antenna*: (Fig. 2, E): Seven segmented; I 0.017 mm long; II sub-pyriform, 0.055 mm long; III sub-cylindric, imbricate, longest, 0.125 mm long with two primary sensoria and a sensorial cone at distal end; IV sub-cylindric, 0.022 mm long; V club shaped, 0.037 mm long with a primary sensorium apically; VI, sub-cylindric, 0.020 mm with a sensorial cone sub-apically; VII sub-fusiform, hairy, 0.035 mm long having a primary sensorium and a sensorial cone in the middle of the segment and a seta at the tip. *Wings*: (Fig. 2, F-G): Forewing 0.75 mm long and 0.18 mm wide, immaculate, not mottled, hyaline and transparent; radius as a smooth flexure and cubitus as a streak. Hindwing 0.65 mm long and 0.18 mm wide, hyaline, not mottled; radius as a smooth flexure. *Legs*: Mesotibia (Fig. 2, H): 0.22 mm long with two mesotibial brush consisting of 2 setae each. Proximal tarsus 0.07 mm long and distal tarsus 0.06 mm long, end with claws and a seta. Metatibia (Fig. 2, I) 0.30 mm long. Metatibial comb consisting of 12 setae and a brush with 2 setae. Proximal tarsus 0.08 mm long and a distal tarsus 0.07 mm ending with claws and a seta. *Genitalia*: (Fig. 2, J): Parameres 0.11 mm long and 0.022 mm wide, wider in the basal part and tapering apically forming an apical spine. The inner margin of paramere has 4 setae, outer margin 7 setae, and the mid region with 8 setae. Aedeagus 0.1 mm long and 0.007 mm wide, broad at base and bluntly tapering at the distal end.

FEMALE: Body length from vertex to tip of ovipositor, 1.290 mm. *Antenna:* Seven segmented, I 0.017 mm, II 0.06 mm, III 0.135 mm, IV 0.022 mm, V 0.037 mm, VI 0.035 mm and VII 0.037 mm. The primary sensorium and a sensorial cone as in male.

Wings: Forewing 0.90 mm long and 0.22 mm wide. Hindwing 0.76 mm long and 0.21 mm wide. *Legs*: Mesotibia 0.24 mm long, proximal tarsus 0.06 mm long and distal tarsus 0.07 mm long. Mesotibia 0.33 mm long, proximal tarsus 0.07 mm long and distal tarsus 0.07 mm long. Mesotibial brush, metatibial comb and brush as in male.

3. **Lipaleyrodes euphorbiae**
David and Subramaniam
(Fig. 3, A-J)

Lipaleyrodes euphorbiae David and Subramaniam, 1976, *Rec. Zool. Surv., India*, 70:202.

Pupal case: Pupal case found in groups on undersurface of leaf and to a limited extent on upper surface also with dense bluish white fluff of fleecy curled filaments of wax. Body white, oval 0.71-0.78 mm long and 0.51-0.60 mm wide.

Margin: Finely crenulate, paired anterior and posterior marginal setae, 5 µm and 11 µm long respectively. Thoracic and caudal tracheal pores and combs absent.

Dorsal surface: Three pairs of dorsal setae: cephalic setae 12.5 µm-140 µm long; I abdominal setae minute, 7.5 µm-11 µm long, in *Phyllanthus maderaspatensis* measures 137.5 µm long; VIII abdominal setae laterad of base of vasiform orifice, 80-105 µm long. Caudal setae 80 µm-110 µm long. Abdominal segments distinct, pockets well developed and contiguous, abdominal segment VI 55 µm; VII medially short, 5 µm: VIII longest 55 µm.

Dorsal disc separated from submargin by a distinct line. Submargin broad with 11 pairs of clusters of wax plates each cluster consisting of 5 to 16 polygonal shaped wax plates (Fig. 3, B). Eight pairs of minute setae present in the sub-dorsal area, 4 on cephalic region and 4 on posterior part of abdominal region.

Vasiform orifice bluntly pointed at caudal end, a little wider than long; width 61 µm and length 58 µm; lateral ridges distinct. Operculum wider than long, 30 µm long and 47 µm wide; lingula large, more or less club shaped, exposed bearing a pair of long setae sub-apically, included but sometimes extended beyond posterior margin of orifice.

Ventral surface: A pair of ventral abdominal setae cephalad of base of vasiform orifice 8 µm long, 25 µm apart. A minute pair of setae present at base of rostrum and legs.

Materials examined: Holotype and 17 paratypes on *Euphorbia prostrata.* INDIA: Tamil Nadu, Madurai, 28.1.1967, B.V. David; 4 pupal cases on *Phyllanthus maderaspatensis*, Tamil Nadu, Padappai, 1.7.1992, K. Thenmozhi; 3 pupal cases on *Phyllanthus amarus,* Tamil Nadu, Padappai, 1.7.1992, K. Thenmozhi; 10 pupal cases on *Phyllanthus acidus,* Tamil Nadu, Padappai, 8.3.1993, K. Thenmozhi; 2 pupal cases *Euphorbia* sp., Port Blair, 11.1.1990, Coll. C.R. Ramesh; 2 pupal cases *Phyllanthus* sp., Port Blair, 11.1.1990, coll. C.R. Ramesh.

Host: *Euphorbia prostrata, Phyllanthus maderaspatensis, P. amarus (=niruri), P. acidus* (Euphorbiaceae). *Phyllanthus acidus* is a new host record for this species.

Distribution: INDIA: Tamil Nadu (Padappai, Madurai); Karnataka (Bangalore); Andaman and Nicobar Islands (Port Blair).

Egg: In *Euphorbia prostrata* eggs are laid on under surface deposited with waxy secretion. In *Phyllanthus maderaspatensis* (Fig. 3, C) and *P. amarus* the female lays eggs on both surfaces of the leaf. Before egg laying the female deposits wax powder on the leaf surface and then lays eggs in a scattered manner. Freshly laid eggs are pale cream and later turn dark brown. The egg measures 0.2 mm long and 0.11 mm wide, pedicel 0.003 mm long. In *P. acidus* the female deposits powdery wax in a circular ring and then starts egg laying in the same manner. Egg measures 0.19 mm long and 0.11 mm wide; pedicel 0.003 mm long.

ADULT MALE: Body light yellow, head and thorax light brown, abdomen, antennae and legs pale; wings hyaline and eyes maroon, constricted in the middle and joined by a single ommatidium (Fig. 3, D). Body from vertex to tip of abdomen measures 1.11 mm. *Antenna:* (Fig. 3, E): Seven segmented; I broader than long, 17.5 µm x 135 µm; II sub-pyriform, hairy, longer than wide, 45 µm x 25 µm;

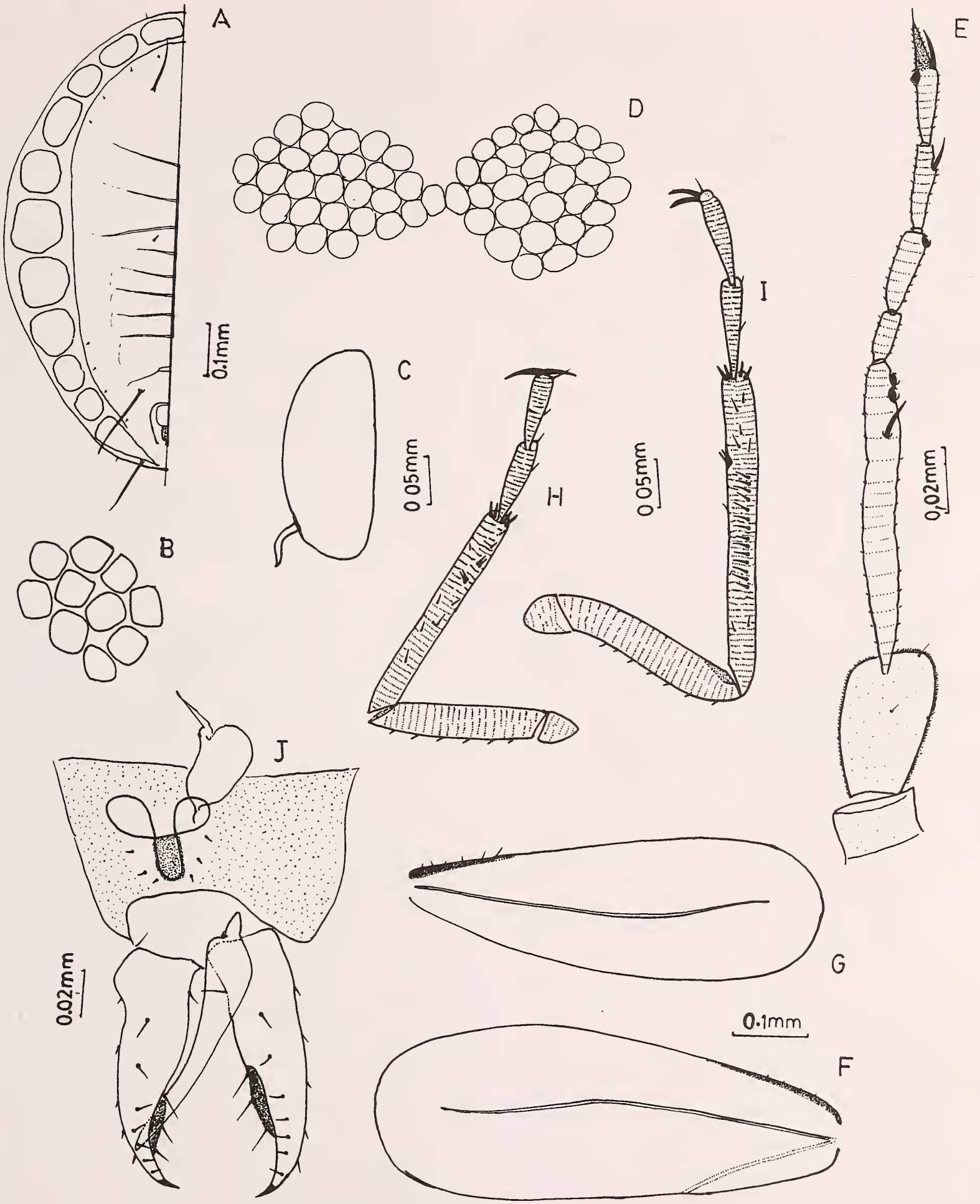

Fig. 3. *Lipaleyrodes euphorbiae* David & Subramaniam: A. Pupal case; B. Cluster of wax plates; C. Egg; D. Compound eyes joined by single ommatidium; E. Antenna of male; F. Forewing of male; G. Hindwing of male; H. Mesothoracic leg of male; I. Metathoracic leg of male; J. Male genitalia.

III sub-cylindric, imbricate, longest, 110 µm with two primary sensoria and a sensorial cone sub-apically; IV sub-cylindric, 17.5 µm long; V club shaped, broader apically and slightly narrow in the basal part, 30 µm long with a primary sensorium apically; VI sub-cylindric, 25 µm long with a sensorial cone sub-apically; VII sub-fusiform, 30 µm long with a primary sensorium and a sensorial cone in the middle and a seta at the tip. *Wings*: (Fig. 3, F): Forewing 0.72 mm long and 0.22 mm wide, not mottled, hyaline, immaculate; radius as a smooth flexure and cubitus as a streak. Hindwing (Fig. 3, G) 0.64 mm long and 0.20 mm wide; radius as a smooth flexure. *Legs*: Mesotibia (Fig. 3, H) 0.24 mm long with 2 mesotibial brush consisting of 2 setae; proximal tarsus 0.07 mm long and distal tarsus 0.06 mm long ending with claws and a seta. Metatibia (Fig. 3, I) 0.31 mm long with metatibial comb consisting of 14 setae and a brush consisting of 2 setae. Proximal tarsus 0.09 mm long and distal tarsus 0.07 mm long. *Genitalia*: (Fig. 3, J): Paramere 0.107 mm long and 0.02 mm wide. Inner margin of paramere consisting of 4 setae, one at basal end and 3 at inflatable sac. The outer margin has 5 setae and the mid region 7 setae. Paramere broader at distal end and tapering at apical end forming an apical spine. Aedeagus 0.10 mm long and 0.077 mm wide, broader at the base and tapering at apical end.

FEMALE: Body from vertex to tip of ovipositor 1.20 mm. *Antenna:* Seven segmented: I 0.02 mm, II 0.057 mm, III 0.11 mm, IV 0.017 mm, V 0.035 mm, VI 0.027 mm and VII 0.04 mm. Primary sensorium and sensorial cone present as in male. *Wings*: Forewing 0.92 mm long and 0.32 mm wide; hindwing 0.69 mm and 0.27 mm wide. *Legs*: Mesotibia 0.25 mm long, proximal tarsus 0.092 mm long and distal tarsus 0.087 mm long. Metatibia 0.31 mm long, proximal tarsus 0.11 mm long and distal tarsus 0.11 mm long. Mesotibial brush, metatibial comb and brush as in male.

4. **Lipaleyrodes vernoniae** sp. nov.

(Fig. 4, A-I)

Pupal case: White, oval, found in groups on under surface of leaves with a dense white fluffy and fleecy curled filaments of wax. Body length 0.810 mm and width 0.520 mm.

Margin: Margin finely crenulate. Paired anterior and posterior marginal setae respectively 10 µm and 25 µm long.

Dorsal surface: Dorsum with three pairs of dorsal setae: cephalic 100 µm, I abdominal 75 µm, VIII abdominal laterad of base of vasiform orifice 95 µm. Caudal setae submarginal 105 µm. Abdominal segment VI 37.5 µm, VIII 55 µm and VII medially shortened. Dorsal disc separated from submargin by a distinct line. Submargin 80 µm broad with 11 pairs of clusters of wax plates, each cluster consisting of 6-11 petal-like irregular shaped wax plates (Fig. 4, B).

Vasiform orifice bluntly pointed at caudal end, 90 µm long and 75 µm wide. Operculum wider than long, 55 µm x 40 µm. Lingula large, exposed, setose, bearing a pair of long setae sub-apically.

Ventral surface: A pair of ventral abdominal setae 25 µm long and 37.5 µm apart. Setae at base of rostrum and legs wanting.

Materials examined: Holotype 1 pupal case, on *Vernonia cinerea.* INDIA: Padappai, 21.1.93; K. Thenmozhi. *Paratypes:* 9 pupal cases on slides bearing same data; one pupal case bearing the same data in the collection of the Division of Entomology, IARI, New Delhi.

Host: *Vernonia cinerea* (Compositae).

Distribution: INDIA: Tamil Nadu (Padappai).

Egg: Eggs are laid near basal part of under surface of leaf deposited with powdery wax. Freshly laid eggs are cream coloured and later change to dark brown. Egg 0.19 mm long and 0.10 mm wide, sub-oval with smooth surface (Fig. 4, C).

ADULT MALE: Body pale yellow, wings hyaline, eyes maroon, divided and joined by single ommatidium (Fig. 4, D). Body from vertex to tip of abdomen 1.08 mm. *Antenna*: (Fig. 4, E): Seven segmented; I 0.017 mm long and 0.032 mm wide; II sub-pyriform, hairy, 0.052 mm long and 0.032 mm wide; III sub-cylindric, imbricate, longest, 0.12 mm long with two primary sensoria and a sensorial cone sub-apically, IV 0.03 mm long, V club-shaped, 0.035 mm long with a primary sensorium apically; VI cylindric, 0.025 mm long with a sensorial cone

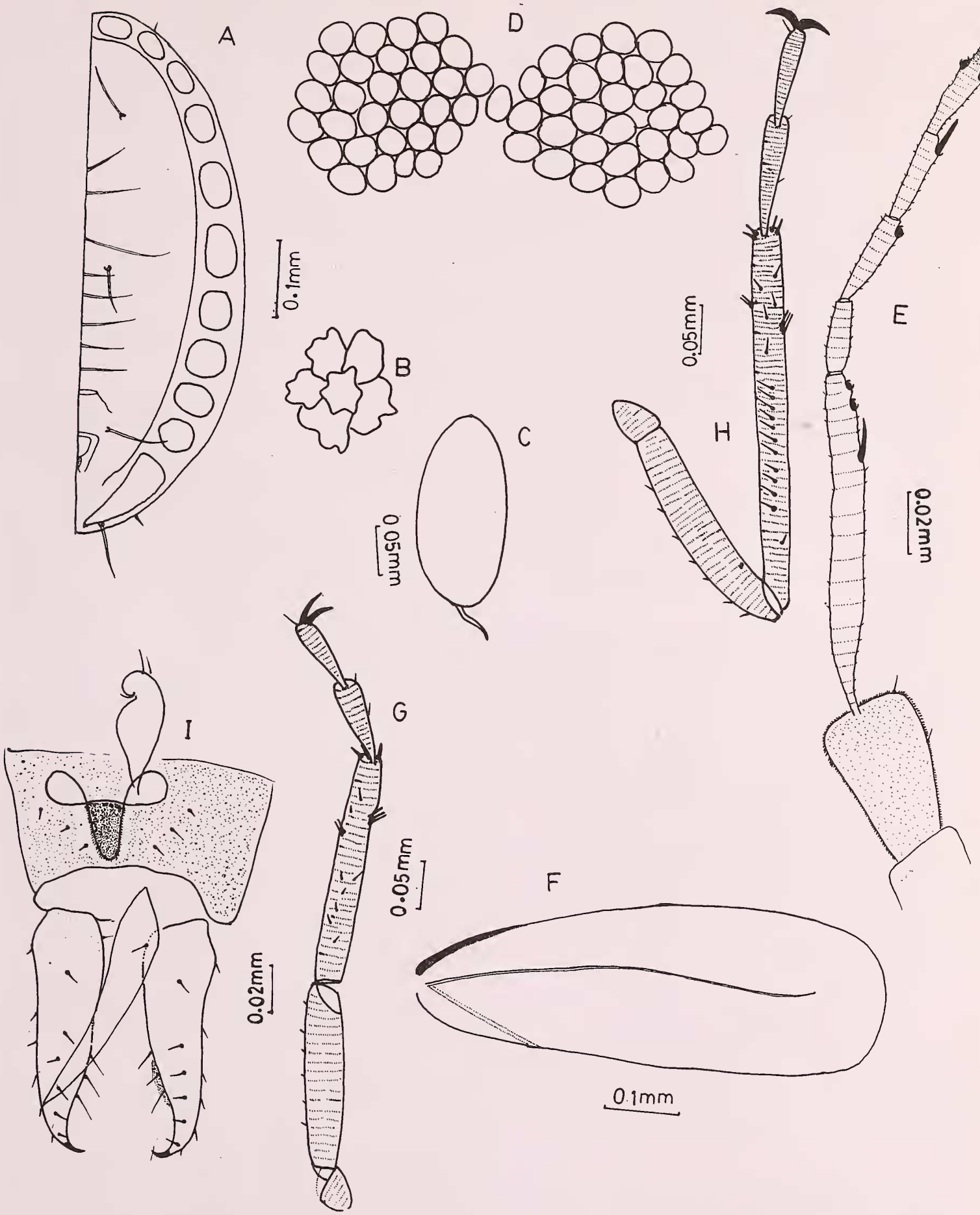

Fig. 4. *Lipaleyrodes vernoniae* sp. nov.: A. Pupal case; B. Cluster of wax plates; C. Egg; D. Compound eyes joined by single ommatidium; E. Antenna of male; F. Forewing of male; G. Mesothoracic leg of male; H. Metathoracic leg of male; I. Male genitalia.

subapically; VII sub-fusiform, 0.035 mm long with a primary sensorium and a sensorial cone in the middle of the segment and a seta at tip. *Wings* (Fig. 4, F): Forewing 0.91 mm long and 0.21 mm wide, not mottled, hyaline, immaculate, radius as a smooth flexure and cubitus as a streak. Hindwing 0.61 mm long and 0.16 mm wide; radius as a smooth flexure. *Legs*: Mesotibia (Fig. 4, G) 0.22 mm long, two mesotibial brushes consisting of 3 and 2 numbers of setae; proximal tarsus 0.07 mm long and distal tarsus 0.06 mm ending with claws and a seta. Metatibia (Fig. 4, H) 0.31 mm long, metatibial comb consisting of 11 setae and a brush consisting of 3 setae; proximal tarsus 0.08 mm long and distal tarsus 0.07 mm long ending with claws and a seta. *Genitalia* (Fig. 4, I): Parameres 0.10 mm long and 0.027 mm broad, broader at distal end and tapering at apical end forming an apical spine. Each paramere consisting of 6 setae in the middle, 4 on the inner margin and 5 on the outer margin. Aedeagus 0.09 mm long and 0.007 mm wide, bluntly tapering at apical end.

FEMALE: Body length from vertex to tip of ovipositor 1.350 mm. *Antenna:* Seven segmented: I 0.025 mm, II 0.062 mm, III 0.125 mm, IV 0.022 mm, V 0.035 mm, VI 0.027 mm and VII 0.046 mm. Sensorial cone and primary sensorium present as in male; *Wings*: Forewing 0.79 mm long and 0.23 mm wide; hindwing 0.67 mm long and 0.20 mm wide; *Legs:* Mesotibia 0.25 mm long, proximal tarsus and distal tarsus 0.07 mm long. Metatibia 0.30 mm long, proximal tarsus 0.1 mm and distal tarsus 0.08 mm. Mesotibial brush, metatibial cone and brush as in male.

Discussion

The study has shown the presence of 4 species of *Lipaleyrodes* in India out of 5 species known so far in this genus, and one has been found to be new to science.

In all the species there are uniformly 11 pairs of clusters of wax plates in the submargin excepting in *L. phyllanthi* which has been reported to have 10 to 12 pairs. However, considerable difference has been noticed in the number, size and pattern of wax plates in a cluster in each species. The wax plates are polygonal in *L. euphorbiae,* oval in *L. breyniae* and *L. crossandrae,* hexagonal in *L. phyllanthi* and characteristic irregular petal-like in *L. vernoniae.* The dorsal setae are extremely long in *L. crossandrae,* whereas first abdominal setae are wanting in *L. breyniae* and *L. phyllanthi.* In *L. vernoniae* the dorsal setae are more or less of uniform size, whereas in *L. euphorbiae* the first abdominal setae varied in size from minute to long. *L. euphorbiae* differed distinctly from all other known species in possessing 8 pairs of minute setae in sub-dorsal area, 4 on cephalic region and 4 towards posterior part of abdomen.

L. euphorbiae occurs on euphorbiaceous plants whereas *L. vernoniae* is known from Compositae. *L. crossandrae* infests plants belonging to Amaranthaceae and Acanthaceae, whereas *L. breyniae* is restricted to plants belonging to Euphorbiaceae and Papilionaceae. It is interesting to note that *L. phyllanthi* occurs on *Phyllanthus* sp. in Madagascar and is similar to *L. breyniae* in not possessing the first abdominal setae but differs from it in having hexagonal wax plates.

The study of adult characteristics has shown that the compound eyes are joined by single ommatidium in all the species examined. No significant variation has been noticed in the antennal structures of both male and female. Eggs and wings also did not exhibit any difference. Variations could be noticed mainly in the mesotibia and metatibia and in the male genitalia which are presented in Table 1.

Gill (1990) has highlighted the joining of upper and lower section of compound eyes by ommatidium. According to Esther (1991) in *Aleurolobus orientalis* (Aleurolobini), *Trialeurodes ricini* and *T. vaporariorum* (Trialeurodini) the compound eyes are distinctly separated and not connected by ommatidium. On the other hand she observed species studied under Dialeurodini and Aleyrodini have compound eyes joined by two ommatidia, whereas in *Bemisia tabaci* (Bemisini) they are joined by single ommatidium. Interestingly in the species of *Lipaleyrodes* (Lipaleyrodini) they are joined by

TABLE 1

Species	Mesotibia		Metatibia			No. of setae in paramere		
	No. of brush	No. of setae in each brush	No. of brush	No. of setae	No. of setae in the comb	Inner margin	Outer margin	Mid region
L. euphorbiae	2	2/2	1	2	14	4	5	7
L. crossandrae	2	2/2	1	2	12	4	7	8
L. vernoniae	2	2/3	1	3	11	4	5	6
L. breyniae	*	*	*	*	*	4	7	7

* Not observed: From figure of Singh (1931).

single ommatidium. It may be of interest to note that the pupal case of Bemisini and Lipaleyrodini look alike except for the demarcation of submargin with clusters of wax plates. Joining of compound eyes by single ommatidium is probably characteristic of the tribes Bemisini and Lipaleyrodini which needs to be confirmed by the study of considerable number of species from the tribes.

The variations in the number of setae in meso- and metatibial brush and in the metatibial comb in addition to the variations in the setae present on inner and outer margins and mid region of parameres are of significance in aleyrodid taxonomy at species level.

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